Lab 1

Introduction to Remote Sensing

Purpose

The purpose of this lab is to give an introduction to earth science applications of remote sensing. It is also designed to give you firsthand experience and image interpretation and relating what you see in a satellite image to physical and biological processes occurring on the earth.

The lab is in the form of an Adobe Acrobat PDF file so it should appear identical on any computer

You can use the magnifying glass in the Acrobat reader program to zoom in and out of the images By holding down on the control key you can zoom out.

There are also hypertext links to sites containing more specific information on the sensors.

IF YOU HAVE ANY PROBLEMS DO NOT HESITATE TO CALL OR EMAIL ME!

Exercise 1: Landsat Thematic Mapper

The first 3 figures are Landsat Thematic Mapper (TM) images of a portion of Bolivia.

- The first image is an RGB (Red-Green-Blue) of the three bands in the visible portion of the spectra.
- The second figure is also and RBG image but of TM bands 5 4 2. The third image is a grayscale image of the normalized difference vegetation index of the same area. A grayscale image has 256 values ranging from 0 (black) to white (256). Red-Green-Blue images are simply a composite of three grayscale images, but with the colors in RBG ranging from black to the maximum intensity of that color.
- The fourth figure is a generalized reflectance curve of some basic land surface types and shows the spectral location of the Landsat bandpasses.

Questions:

A) Identify the 5 different features in this image (e.g. is it a river, vegetation, etc.) The reflectance figure may help.
   1)

   2)

   3)

   4)

   5)

B) As this is a geography class what exact geographic features do you think the following numbers are (A good Atlas should help):
   2)

   3)

   4)

   5)

C) Which of the two color composites do you think provides the most valuable information about the land surface and why is this so?

D) Examining the normalized difference vegetation index (NDVI) and the reflectance figure calculate the NDVI value and corresponding color in the grayscale image you would expect for:

Vegetation:

Soil:

Snow:

One reason that ratio images are used is because the help alleviate the effects of topography. Notice in the differences in lower right corner between the 542 and NDVI images.

E) Note the sharp break in NDVI values between the upper right and lower left portions of the image. Explain the reason for this difference and why it is so abrupt (Hint: think about the geographic location of the features in the image)?

Exercise 2: AVHRR imagery

The next four images are from the NOAA Advanced Very High Resolution Radiometer (AVHRR). Although designed primarily for meteorological applications, AVHRR is a polar orbiter that has been used extensively to study global vegetation dynamics among many other things. They are GVI (Global Vegetation Index) images for the Northern Hemisphere for four periods in 1996. They were created by Ralph E. Meiggs, Physical Scientist, NCDC. The purpose of these images is to allow you to examine temporal changes in satellite images on a broad scale and the images can be interpreted in the same way as the NDVI image calculated from the Landsat TM scene. NOTE HOWEVER THE COLOR SCALE IS INVERTED – DARK VALUES ARE HIGH NDVI VALUES.

Questions:

A) In which of the four periods does the Northern Hemisphere have the most vegetation?

B) What do you think may be the cause of the low NDVI values over the Canadian Prairies and in the upper Midwest during February?

C) Notice the changes GVI values for northern Africa over the year? Can you explain why the GVI values change (what on the surface is changing)? Can you propose the cause of the land surface change? Again this is a geography class – what is this area known as?

D) Why are GVI values lower in November for the eastern United States than in August?

E) Note that the images are composites over 6 day periods. Why do you might think that the GVI values Indian Subcontinent appears patchy in August and are quite low?

Exercise 3: Defense Meteorological Satellite Program (DMSP)

In addition to NOAA, the Department of Defense operates a series of polar orbiting environmental satellites to support its operations through a program called the Defense Meteorological Satellite Program. For the public sector these data are archived by NOAA. One of the instruments on these DMSP satellites is the Operational Line Scanner (OLS). Like AVHRR it operates in both the Visible/Reflective IR and Thermal IR. These satellites collect data both during the day and at night.

The next 4 images are two visible and two thermal images taken on January 1st and 2nd, 1997.

Questions:

A) Which pair (A or B) do you think was collected at night and why do you think this?

B) Comparing the visible and thermal images, in general which portion of the spectra do you think is most useful for meteorological applications. Why do think this.

C) Can you think of any possible uses of an image such as the visible image in B?

Exercise 4: Geostationary Operational Environmental Satellites (GOES)

GEOS satellites are probably the most well known to people living in the United States as the provide valuable meteorological information. As images from GEOS satellites are very popular there are many web sites providing GEOS imagery and information. NOAA has a GEOS imagery web browser.

The next six images are from the current GOES-EAST satellite. They are from early February 1997 and depict the strong storm pummeling the East Coast at this time. The images are in three spectral bands and are from 2 different times.

Questions:

A) What time of day on the East Coast do you think the images at Time 1 where acquired?

B) How about at Time 2?

C) In general, the time an image is acquired by a satellite is not given in local time, but rather it is given in Coordinated Universal Time (UTC). For uses where accuracy greater than seconds is not important UTC can be considered equivalent to Greenwich Mean Time (GMT). For information about UTC and other clocks visit the National Institute of Standards. At what approximate UTC time do you think these images were acquired?

D) Examine the Thermal IR images (TIR – 10.7 micrometers). Do you think lighter colors represent warmer or colder temperatures and why do you think this?

E) Notice the difference in the land surface at 10.7 micrometers (especially Central America) between the two times. What may be responsible for the differences?

F) Why do you think some clouds are brighter than others in the 10.7 micrometer image? Why is this so? What possible information about cloud properties might be extracted from this thermal imagery?

G) Now examine the 3.9 micrometer images. In these wavelengths what might be the cause of the differences in the land surface between the two times (especially in central and South America)? The figure following the GOES images may help. It shows blackbody curves for both solar and terrestrial temperatures.

H) Why do you think the western coast of South America is especially dark in Time 2?

Exercise 5: ASTER Images

These last set of images are images that are supposed to simulate data that will be acquired by the ASTER instrument that will fly aboard the NASA EOS-AM1 platform. It is a high resolution instrument like Landsat TM, but has more bands, especially in the thermal wavelengths. These two images are simulated images from Death Valley, CA. You can check out the ASTER web site to find out all about them. The image on the left is a visible image while the image on the right is a TIR image. As you can easily see, each wavelength provides information the other does not.

Questions:

A) How come the visible image appears sharper than the thermal image?

B) Why do areas that appear light in the visible image appear dark in the thermal image (A) and those that appear dark in the visible image appear light in the thermal image (B). REMEMBER, unlike GEOS the thermal image is not inverted.

C) Again, this is a geography class. What are areas and why are they so bright in the visible (A)?

D) Areas (C) and (D) are known as alluvial fans. They are composed of material that has been transported out of the mountains (not shown) and is deposited when the gradient changes from mountains to the valley. If we assume that the materials are at the same temperature, why can the two alluvial fans be distinguished so easily in the thermal image?

Lab Evaluation

Now its your turn to evaluate me. This is totally optional, but your feedback is important to help me improve the labs and my performance. Also, if you prefer you can hand it in separately and maintain your anonymity.

On a scale of 1 (cow dung) to 5 (Fillet Mignon)– apologizes to the vegetarians in the group, but I am from Iowa – please rate this lab.

1 2 3 4 5

How worthwhile was it?

1 2 3 4 5

How long did it take you to complete the lab?

What did you like about the Lab?

How can it be improved?

Any other comments?